The Other Side of Color Management

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Abstract

As we witness the coming to maturity of color management technology, questions still remain: have we really solved the BIG problem of color use on the computer? Is the current solution the right solution? What are the real obstacles in making computerized color work productive?

Color fidelity between devices has been (still is?) a BIG problem and much effort and progress has been made towards solving it. Are there other problems with color work on the computer?

For most people using color is difficult. Instead of being easier, working with color on the computer is more arduous and complex than when using traditional methods! How can we make working with color less of an effort and more enjoyable for computer users? What are the obstacles preventing computer developers from doing this? How do we really empower computer color users?

By transforming the way that color work is done:
- Redefine the place color takes in computer systems.
- Provide real tools to manage color work.
- Provide tools that make computerized color work natural, creative and satisfying.

Keywords: color management, color tools, using color, color UI's, user interface

1. Introduction

During the past decade a great deal of scientific and engineering effort has been expended in order to develop something called "color management". The reason for this is that color work on the computer has been hamstrung because colors reproduced on one device are not necessarily indicative of the same colors on another. The goal and eventual outcome of this is essentially the establishment of a rigorous fidelity for color between computerized input and output devices. Certainly this is a worthy effort and much progress has been made towards it's end.

The problem is that working with color on the computer is difficult not only because of problems with color fidelity. The color fidelity problem, in a way, is a passive problem. It is an artifact of using more than one color media for color work, it has little to do with the actual mechanics of creating with color. So the term "color management", however descriptive of the technology, is misleading to some. Using "Management" in the term would suggest that color is a resource that is being managed not only to control its behavior, but also to make it more accessible, to enhance its usefulness, and to increase a user's productivity and the quality of their color product. Some may say that this is a trivial semantic point, that the use of the term "color management" may connote more than it is but, so what? Well the point is that the term is appropriate, and we should aim to fulfill all of its promise.

2. Color on the Computer

The direction of the application of color on the computer has been traditionally two-fold; to provide a large number of quickly managed colors at low cost and to provide color that is relevant to the real world. Accordingly, color tools have been designed to allow the user to pick and use hundreds to millions of colors and to allow those colors to be displayed on a variety of output devices. Color pickers based on various color models are available: the PANTONE® system, CMYK, RGB, HSB etc..

Color on the computer is an artifact. It does not exist until pixels are colored or a colored object is created in an application. In the last fifteen years, or so, computer applications have expanded their individual functionality from black and white and gray scales to hundreds, thousands and millions of colors. Historically this improvement has been accomplished not so much by rethinking and redesigning but by simply assigning colors to existing black and white tools so that they can draw and manipulate colors.

Pixel paint programs are based on real world professional paradigms and have achieved a universal appeal. Using pens, erasers, brushes and common shape constructs like rectangles, curves and ellipses, the user can easily draw pictures on the computer screen. These programs have a widespread appeal and a reputation for easy use. Why? Because everyone has experienced drawing and painting at some time in their lives and these programs are designed to be intuitive and fun to use.

Photo imaging programs have used the paradigm of the print shop and photographic darkroom. When photographic and graphic professionals were the predominant users this approach worked well, but today the non-professionals want to use these applications. The majority of computer users have little or no background in the photographic and printing arts. The average computer user can relate to the desktop metaphor but not to the photo lab paradigm. In fact, imaging programs have a reputation for being complex and hard to learn and use. Imaging applications may be used with aplomb by most graphic art and photography professionals, but not by others.

Recently a new type of color application has appeared: paint simulation applications. These applications have drawing/painting tools that treat the application of color in a

new dynamic way. Color application tools are simulated to respond in ways similar to various real world pigment media, like: felt markers, oil paint, water colors, chalk, pastel, pencil and more. Color applied by these tools is affected by a number of factors including, the texture and color of the simulated surface it is being applied to, the underlying layers of colors that were applied before, and the bleed rate, spread and opacity of the color.

Using these color applications, how often has the average user produced an image that has been more than just satisfactory and truly desirable and pleasing? Not very often. Why?

3. How People Use Color in the Real World

The history of computer based applications has been one of translating activities performed in the real world, by hand, into the functionality of the keyboard, cursor device and 2D screen of the computer. Since their inception, computers have struggled to fit naturally into the world of mankind. Practically all of us have learned to live and work by relying on our personal visual perceptions of the world around us and by manipulating the objects contained in that world. Since most of us have experienced working at a desk, the desktop has been taken as a metaphor for the current standard of human-computer interaction. Simple familiar objects like file folders, trash cans, document pages etc. represent files, utilities, resources and applications. These objects are manipulated in familiar consistent ways: objects can be created, edited, moved, stored, combined and thrown away using simple actions of clicking, dragging and typing that simulate the picking up, moving and writing of the real desktop operations.

The computer draws upon non-computer related experience and expertise to allow the user to do work. Because of this, users are immediately comfortable and feel more involved, system basics are simpler, there is less to learn (and forget) and the computer is more easily integrated into daily routines. This technique of using a real world metaphor as the basis of the "look and feel" of a computer operating system has been used in the design of computer applications.

In my earlier study of how people work with color in the real world the following methods were identified.[1]

Limit the number of choices available. Color picking is a process of elimination. When picking from a large number of colors first people will eliminate large groups of colors and then smaller and smaller numbers until the desired one is left. Consumers are usually presented with products available in only a small limited, number of colors.

Make other related decisions or let associated pertinent factors help to direct them in their color choices. Choosing the color media, type of printing process or a particular brand of clothing will influence the number and type of colors available.

Use the objective and the context in which the color is to be used is used as a guide for making basic color decisions. Analyzing who will be viewing and interacting with the color, and what the desired message and mood is, will provide a direction for appropriate color choices.

Ask others to help them make color decisions or relegate or relinquish the choice to others. They may ask specific questions hoping that the answers will help direct them in their color decisions: "Which of these three colors do you prefer?" or "How many colors in this job?"

Use experiences and decisions from the past to provide a direction for the use of color. The same set of colors could be used over and over, a set of colors may be used exclusively for a time and then new ones based on the old ones are developed, or the colors may change over time but the method that is used to work with and pick them remains constant. Color preferences may fluctuate because of some event or change in ones' life or environment, or because of some new experience. The world around us constantly influences our lives. Using observation as a guide, one may copy or modify the color work of others, or use the many random and planned color schemes around us for inspiration.

Acquire, develop and use pre-set color schemes. These schemes may be used as a starting point in determining a final set of colors or used straight as the actual colors in a piece. These schemes may not be actual sets of hues but a defined set of color relationships.

Use iteration and experimentation to choose colors and create designs. Designing a composition is the process of delimiting colors and shapes and defining their relationships with each other. How much of each color, which colors will meet, where will they meet, how will they meet, which will dominate, which will recede? By answering these and other questions one produces a cohesive color composition. Unfortunately this process is very complex. Most compositions are derived through experimentation, educated and intuitive guessing and trial and error. There is no real substitute for training, talent and experience.

Use established principles of color design and composition. There are some accepted principles, theories, schemes and methods for using color. Designers, fine artists and graphic artists are trained in these methods and with practice and experience become somewhat conversant and proficient at using color. The average person is unlikely to have the time, the inclination or the energy to train in the use of color and assimilate the required skills through years of practice. In large part this is due to the fact that the application of color design rules is very complex. The use of color is often based on personal insight and the rules of color application are applied in imprecise, intuitive ways. Traditionally, using color well is a skill that is acquired by a long process of education, training, practice and experience.

These are common methods used for accomplishing a variety of color work. In this light the tools provided for working with color on the computer are terribly inadequate parallels to real world color work. The current batch of computer based color tools force users to work in non-intuitive color spaces like RGB, CMYK and HSB, to choose among and use millions of colors, to mix colors like paint or to use pre-defined hard coded color palettes. Almost no tools are provided to organize, develop and use personalized color schemes and palettes. Creating with color across applications and on multiple platforms is very difficult if not impossible. Color applications do not have tools that facilitate color specific tasks for novice and casual users; ones that guide them in ways that build personal knowledge and expertise. In fact the current trend in color device

drivers and low-end color applications is to hide the true workings and relationships of color work behind over simplified metaphors and mixed-up functionalities. For example, the current batch of scanning utilities rely on the concept of identifying an image type (photo, line art...) and target printer in order to specify the scanning resolution, color mode and bit depth. The result of this is that knowledgeable users are hard pressed to make sense of what is going on and are frustrated by a lack of direct control and novices have little chance to learn the skills and concepts needed to improve their work.

4. A Success Story

The fact is that the average user has trouble using drawing and imaging applications and utilities. Graphical page layout programs, on the other hand, have seen a dramatic growth in popularity. Why have these computerized document programs become so widespread and accepted? Answering this question will shed some light on what needs to be done to make computerized color use easier, enjoyable and more productive.

Computerized document creation meets a real need. Many people in a wide spectrum of occupations spend a good portion of time producing documents, both for work and for personal matters. These computerized systems make document creation easy and flexible and produce results that are better than those produced off line. Page layout programs provide a means for linking many other types of commonly used applications, text editing, spreadsheet, financial, management, database, graphing, drawing and imaging programs.

Document creation is based on skills and tasks that are basic and familiar to the average person. Most people have written numerous papers in school; they all are familiar with formatting paragraphs, using type styles, placing titles, setting margins, etc. People are very familiar with newspapers, magazines, books and advertising; at a semiconscious level they have assimilated the design principles of each of them. We navigate through newspapers, books, and magazines by analyzing the size and placement of their typographical elements. Unconsciously, the average person has the basic knowledge and training to work with typographic elements and to accomplish some rudimentary page layout.

The designers of computerized page layout programs purposefully did two things that contribute greatly to their success. First, *the programs are designed in a way such that by using a very small set of familiar operations, the user is able to quickly produce a very satisfactory product.* Just by choosing a type style, typing characters, setting paragraph formats, page sizes and borders a pleasing document can be created. Second, *page layout programs use techniques and terminology taken from the typesetting/paste-up profession.* This accomplished two things. Professionals were able to understand, be comfortable with, use and integrate these applications into their operations within a reasonably short training period. Non-professionals became familiar with professional terms and techniques and those who ventured beyond the basic functionality of the programs expanded upon what they could accomplish. Users were encouraged to progress further and learn more by us-

ing the advanced layout design templates included in the applications package. With this increased familiarity, many of the resources, books, classes and tools available to the professional were understandable and accessible to them.

Interest and demand for computerized page layout has resulted in the proliferation of a whole number of specialized courses and books, computer rental, copy and printing centers, and professional desktop publishing services. Likewise, the success of these programs has added to the strong, increasing demand for more powerful computers and bigger higher resolution monitors, printers and copiers, and new software like utilities that organize fonts and styles in menus, that make bit mapped fonts scalable and applications that share data with others. Much of the demand for fast graphics computers, large screens, ink jet and laser printers is a reaction to the widespread success of computerized document creation. The proliferation of each of these, in turn, helps add to the success of the computerized document technology revolution, and so on...

It must be realized that on the whole Mr. and Ms. Average have not become professional quality document creators. The fine points of page layout are not in the process of becoming basic common knowledge. Most documents are still created in word processing and not in page layout applications (though to be realistic, text editors are swiftly incorporating many of the features of page layout programs). Almost all complex or challenging documents are created and produced by professionals, almost exclusively on the computer. Perhaps there is a limit to the time and energy that the average person will spend on beautifying documents. What is that limit? Users would be very upset if we took away the ability to change fonts or specify type styles. On the whole document beautification as time well spent; what is good content without proper presentation?

5. Toward Better Color Work

Taking direction from the success of page layout programs, and using the Canon Color Advisor as an example for what kinds of new tool are needed...

Computerized color work meets a real need. Color adds information, draws attention, enlivens and beautifies. In business it is no longer the competitive edge it is the standard. In most cases using the computer is the easiest, fastest and cheapest way of creating color work. For many people the computer is their only means for creating color work. Today, color work done off-line is still more flexible and produces better results, but better color printers and color fidelity software are quickly narrowing that gap.

What is needed are color creation tools that are based on skills and tasks that are basic and familiar to the average person. Tools that create and use small color palettes. Palettes that organize colors into functional groupings. Colors should be selected and color work directed by using related task factors such as the target output media, project budget, project objectives and context. Example: based on users selection of descriptive terms for the document style, audience, occasion and setting the Color Advisor creates a small functionally organized palette of colors. The palette contains thirteen colors organized into the functional groupings of dominant, coexisting, supporting and

highlight colors. This loose functional organization of colors provides an intuitive guide to color usage—most functional color palettes stifle creativity by making specific assignments of colors to distinct elements in a composition or document. The user has the freedom and flexibility to explore and create with the colors by dragging colors from the palette onto document elements.

By using a very small set of familiar operations, the user should be able to quickly produce a very satisfactory product. Color tools should facilitate work based on iteration and experimentation. Tools that start from and build upon color work that has been done in the past and that are based on the use of user defined and customizable pre-set color schemes. It is extremely important to provide a solid starting place for the user to begin color work. The first steps of choosing the first few colors and the initial coloring of the main compositional elements is the hardest part of the work, not only for the novice but also for professionals. Because modifying and building from an existing structure is much more simple and fun than starting from a blank canvas and a million choices of color, once a few colors are chosen and placed the work becomes easier. Example: the Color Advisor includes a set of auto-coloring templates for basic kinds of documents. The templates specify a set of objective terms that define a color palette and then automatically assign colors from that palette to document elements. These templates are not necessarily intended to produce final colorings but are to be used as "quick starts" to help the user begin their own coloring work. The user can experiment by re-coloring document elements individually or in groups. Iteration is accomplished by switching between different auto-coloring templates or by modifying the color palette by selecting different objectives (document style, audience, occasion and setting). Since colored document elements are indexed to color palette entries and the colors within the palette always maintain their functional relationships (dominant, coexisting, supporting and highlight) the user can easily and quickly iterate though color combinations by changing the palette colors. At any point the user can save the current color palette and document element colorings as user-defined auto-coloring templates: saving past work to be a starting point in the future and to be an other source for iteration.

By using established and accepted techniques and terminology the tools make sense to professionals and build knowledge and expertise in the novice user. Color tools should be based on established principals of color design and composition and should be sources for expert advise and guidance. More importantly, they should to be fun to use and stimulate the learning of techniques by doing (optimally without the user knowing that they are learning them). Example: the Color Advisor takes many ideas from the way that professional color design and composition is done. The color palette is created from task objective criteria: document style, audience, occasion and setting. It has a limited number of colors, a distinct layout and a purposeful structure that belies the strict relation of the dominant, coexisting, supporting and highlight to each other. Through use and observation it is hoped that the user will begin to understand and employ techniques presented in the Color Advisor's palette.

6. The Key: Color as a Resource

Today the computer is used as a tool to work with documents composed predominantly of text. That text is words, made-up of characters that have visual attributes of font type, style and size. Since their function is to describe how a specific piece of text should look it would be logical that these attributes exist only if the text that they describe exist. Yet these attributes are independent of the text that they describe and are organized as system wide recourses called fonts. Because fonts are resources they can be managed independently from the text that they describe. Fonts are so independent that there is an industry just to produce and sell fonts and a number of companies that provide software to manage these fonts. Operating systems, applications, computers and peripherals come with fonts. Fonts are text attributes.

By installing and removing fonts at the system level, users decide which fonts will be accessible to their applications and printers. When a font is installed it is automatically and consistently accessible by all of the applications on the system. Individual and groups of fonts can be distributed on removable media, across phone lines and networks so that a distributed consistency of text style and quality can be assured. Distributed fonts allows documents containing those fonts have a consistent look on any machine in the distribution range. With the help of special software utilities, users can organize and group fonts according to their personal work styles and needs; organizing for different projects, clients, esthetic styles and even frequency of use. Other software utilities allow users to preview font styles within application font menus. These utilities also provide options to include in font menus indicators of font type (screen, Type1, Type3, True Type...) and indicators of which fonts in the list are used in the current document. They can make the most frequently used fonts more easily accessible in those menus and may allow the grouping of fonts according to families or other user defined criteria.

Color's place on the computer today it is as an attribute that describes text, images and objects. But, unlike fonts, color is not a system resource. Color is closely linked to the object that it describes: it only exists if the object that it colors exists, it cannot be managed independently. This is not an issue for full color images, they are nothing but color: you manage the image file and you manage the color. It is an issue at the user decision making level where limited numbers of colors are being used to create documents and illustrations.

If color were to become a system resource, then color management beyond color fidelity becomes a feasible reality. Just as character styles come in fonts and font families, colors could be a resource organized as variable sized color palettes. When a color palette is installed it is automatically and consistently accessible by all of the applications on the system. Users could use and distribute pre-defined and custom color palettes in any application and on any machine. Software could be developed to build analyze and manipulate color palettes to organize palettes according to projects, clients, esthetic styles and frequency of use. Individual and groups of color palettes could be distributed on removable media, across phone lines or networks so that a distributed consistency of color usage is assured.

7. Conclusions

Looking at the big picture: the impetus behind the development of color management systems was the fact that most color work done on the computer is unsatisfactory. One of the most identifiable reasons for this is the lack of fidelity between computer controlled color devises. This is where the current emphasis of color management development has been placed. There are other reasons for lack of quality in computerized color work, particularly when looking at the end-user consumer market. Problems are that the available color creation tools are inadequate, complex color work is difficult to organize and manage, and most people, because they have little experience and training working with color, find color work intimidating and difficult.

In order to solve these problems new types of color tools are needed. Tools which allow users to organize, develop and use personalized color schemes and palettes. Color needs to be made into a system resource to make creating with color across applications and on multiple platforms workable. We need color applications and utilities that can facilitate color specific tasks for novice and casual users in ways that build personal knowledge and expertise. These software products should also be useful to the creative professional.

There are two metaphysical barriers to the development of the wondrous color tools described here. There is the "Grand Myth of Computing" with which to contend. Consumers have been led to believe that tasks done on the computer are accomplished with less effort and greater speed than in the coporial world. They have grown to expect and demand this to be true, even when performing complex tasks that are unfamiliar to them. But the truth is that competency and mastery in any endeavor, especially a creative one, requires effort, training, and practice. It is our responsibility as computer professionals, scientists, and engineers to look beyond this myth and to not only make our devices useful and productive but also to produce products that challenge users and help them to better understand and master the creative skills that benefit our societies more than quick fixes and easy answers ever will.

In an industry which is based on technology and science, the problems which get the most attention are those which are the most suited for scientific investigation and technological solutions. The non-color- fidelity problems described in this paper have been all but ignored. With real robust and practical solutions for the color fidelity problem on the horizon, it is time to put some of our attention and energy into fixing the other important "fuzzy" problems of color management.

8. References

1. L. Lavendel, "Color: Use and Abuse", *IS&Ts Eleventh International Congress on Advances in Non-Impact Printing Technologies*, pp. 446-450, IS&T, Springfield, Va., 1995

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